CYCLONES AND ANTICYCLONES.

By EDWARD H. BOWIE.

Of the LOWS that were charted for March, 1 was of the Alberta type, 2 North Pacific, 3 Colorado, 1 Texas, 2 Central, and 1 (No. 12) of semitropical origin. There were 3 Alberta cyclones fewer than usual, but 3 cyclones more than usual originating in the center and south.[1]

Of the HIGHS that were charted, 5 were of the Alberta type, 4 North Pacific, and 2 Hudson Bay. As compared with the average, 1892–1912, there were 3 extra North Pacific and 1 extra Hudson Bay HIGHS.[2]

It will be noted that there was a general tendency of LOWS to move east-southeastward until the 100th meridian was reached and afterwards to move almost due northeast, the regularity of this movement in practically all instances being one of the striking features of the storm movements of March, 1919. The HIGHS moved almost invariably eastward until the 90th meridian was reached, but east of the 90th meridian a number of them moved southeastward to the South Atlantic States; the others continued their eastward march to the north Atlantic coast.

THE WEATHER ELEMENTS.

By P. C. DAY, Climatologist and Chief of Division.

[Dated: Weather Bureau, Washington, May 1, 1919.]

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds for March, 1919, are graphically shown on Chart VII, while the means at the several stations, with the departures from the normal, are shown in Tables I and III.

The average pressure for the month was above the normal over all portions of the United States, save for a small area in the northern Rocky Mountain and Plateau regions, and likewise over Canada as far northward as observations extended. The excess in pressure was most pronounced over the Lake region and thence eastward to the Canadian Maritime Provinces, due mainly to unusually high pressure for the season of the year over those regions about the middle of the month, and again during the early part of the last decade. In the southern and far western districts the average pressure was only slightly higher than normal and, as indicated above, there were slight negative departures in portions of the far Northwest.

The prevailing high pressure in the northern districts from the Great Plains eastward favored northerly winds over most eastern districts. From Texas westward and northwestward over the Plains, Rocky Mountain, and Plateau regions they were mostly from southerly quadrants, while along the Pacific coast they were mainly from the west.

The most notable feature of the winds during the month was the persistence of high velocities in connection with a storm that moved from the Gulf States northeastward to the New England coast near the latter part of the month. During this period winds of gale force, mostly from the Northwest, prevailed for days over the Middle and North Atlantic States, continuing long after the general barometric gradients had lessened to such an extent as to justify the expectation that the winds would have diminished greatly in force.

TEMPERATURE.

At the beginning of the month cold weather prevailed generally over the central valleys and the Northwest, while elsewhere temperatures were near, and in some sections considerably above, the seasonal average. Rapid changes to warmer or colder marked the weather during the greater part of the first decade, although toward the end more stable conditions prevailed. The early part of the second decade was mainly cold over the northern districts, particularly in the more eastern portions, but in the South and far West temperatures were mostly seasonable.

At the beginning of the third decade high pressure overspread the Northwest and there was a decided fall in temperature in those regions, but a quick return to warmer followed, although moderately cool weather continued over the northern districts from the Lake region eastward during much of the decade. In other portions of the country temperatures during the last decade of the month were uniformly near the seasonal average.

For the month as a whole the temperature was decidedly below the average over much of Montana and North Dakota and slightly below from Texas westward and northwestward to the Oregon coast. Over the remaining districts the monthly averages were above normal, but not decidedly so over any extensive areas.

Sharp contrasts in departures within relatively short distances appear in the Northwest where, over portions of central Wyoming, the monthly averages were as much as 7° above normal while in the adjoining State of Montana they were from 6 ° to 9 ° below. In southern Utah and portions of adjoining States the average temperatures were again below normal—a condition that has persisted for each of the five months, November to March, inclusive.

PRECIPITATION.

The month opened with a general storm area passing over the more eastern districts, rain still continuing in portions of New England, and light snows falling locally from the upper Lakes westward to and including the northern mountain districts, and general rains over Oregon and Washington. The weather promptly cleared over most districts and fair weather ruled until about the middle of the first decade, when rain or snow overspread most central and eastern districts and portions of the far West. Rains were fairly heavy and general near the end of the decade from the west Gulf States northeastward, some unusually heavy falls occurring at points in Alabama and Georgia.

The first half of the second decade was mainly without precipitation, but by the middle a well-developed storm had moved into the Missouri Valley and precipitation had

[1] Cf. Mo. Wea. Rev. Suppl. 1, 1914.
[2] Cf. Mo. Wea. Rev. Suppl. 4, 1917.

occurred over wide areas in the central, northern, and western portions of the country. At the same time local heavy rains, amounting to nearly 10 inches in 24 hours, had fallen in extreme southern Florida, causing heavy damages to trucking interests. The eastward progress of this storm brought considerable snow to the more northern districts, and in conjunction with an offshoot that developed in the middle Mississippi Valley heavy rains occurred over wide areas from the central valleys eastward. In portions of western Tennessee the 24-hour precipitation on the 16th and 17th was the heaviest ever known in that region, exceeding 10 inches at a number of points and causing much damage by washing and flooding. (See pp. 189–190 below.)

Following the passage of this storm there was generally but little precipitation over the western districts during the remainder of the month. This was particularly noticeable in the far Northwest, where rain had been of almost daily occurrence during the first two decades.

In the central districts rain again set in about the middle of the last decade and gradually extended eastward, developing into a severe storm with high winds and heavy precipitation over the more eastern districts from the 27th to near the end of the month.

For the month as a whole precipitation was generous and sufficient for all needs over the greater part of the country, although the amounts were slightly below normal over most of the Gulf States and from the Rocky Mountains westward, save in portions of New Mexico, Arizona, and adjacent States. From the middle and upper Mississippi Valleys eastward to the Atlantic coast the monthly precipitation was very generally above normal but usually by rather small amounts, save in portions of the middle Mississippi and lower Ohio Valleys, where large excesses were recorded. Precipitation was unusually heavy also over the greater part of New Mexico and other portions of the Southwest, where drought conditions have persisted for many months.

SNOWFALL.

While snow occurred at some period of the month over the greater part of the country, the amounts were usually small in the central and eastern districts. However, considerable snow occurred in the vicinity of Lake Michigan during the first decade and at points in northern New York and New England near the end of the month. In the mountain districts of the West the snowfall was unusually heavy in portions of New Mexico and the adjoining States and there were substantial additions to the amounts that had accumulated in the higher elevations of California and Oregon. Elsewhere the amounts received during the month were moderate but on the whole the outlook for a sufficient supply of water for the coming summer was very generally improved. This is particularly true in portions of the southern Mountain districts where the heavy snows have assured an abundant supply of water, but they were nevertheless severe on stock, causing heavy losses.

By the close of the month the snow cover had disappeared from practically all the country east of the Rocky Mountains, save in extreme northern New England and over a narrow strip along the northern border from Lake Superior westward. In the far West no snow remained at the lower elevations.

RELATIVE HUMIDITY.

From the Mississippi River eastward the relative humidity averages were nearly everywhere less than normal, and by substantial amounts at points in the Gulf States and Appalachian Mountain districts. To westward of the Mississippi the relative humidity was mostly above normal, by moderate amounts, although small areas in the northern Rocky Mountain and northern Plateau regions had well-marked negative departures.

SEVERE STORMS.

On the afternoon of the 5th severe storms occurred at points in the Middle Gulf States, particularly in Alabama, Georgia, and northern Florida. These were of tornadic character at several points, notably at Eufaula, Ala., where four persons were killed, others severely injured, and much property loss was sustained. Two persons were also killed at Lumpkin, Ga., and much damage to property resulted from the high winds.[1] On the 15th tornadoes or other severe storms were reported from points in Arkansas, Iowa, Kansas, and Nebraska, causing large property damage but without much loss of life.[2] The high winds over the Atlantic Coast States near the end of the month caused some damage to trees and the less substantial buildings.

Average accumulated departures for March, 1919.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departures since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departures since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	In.	In.	In.	P.ct.		P.ct.	
New England	37.2	+4.5	+12.7	4.16	+0.4	+2.1	6.5	+0.8	76	+1
Middle Atlantic	44.1	+4.1	+11.9	3.82	+0.2	−0.7	5.5	−0.2	69	−4
South Atlantic	55.9	+2.0	+ 4.1	2.78	−1.5	−2.0	5.1	+0.2	73	−2
Florida Peninsula	71.8	+1.5	− 0.6	4.99	+2.7	+2.7	4.3	+0.6	74	−4
East Gulf	58.8	+1.6	+ 0.5	5.26	−0.6	+2.3	4.6	−0.5	68	−7
West Gulf	57.8	−0.1	− 0.1	2.76	−0.4	−0.5	5.1	0.0	73	+1
Ohio Valley and Tennessee	46.2	+2.3	+ 7.3	5.46	+1.0	−1.9	5.2	−0.9	68	−4
Lower Lakes	35.8	+2.9	+13.4	3.08	+0.4	−2.2	5.8	−0.7	72	−4
Upper Lakes	31.3	+3.8	+16.4	2.61	+0.3	−1.0	5.7	−0.3	77	−1
North Dakota	18.2	−2.6	+13.8	1.12	+0.2	0.0	5.6	+0.1	86	+8
Upper Mississippi Valley	39.6	+3.6	+15.1	3.70	+0.3	−0.7	5.6	−0.1	74	0
Missouri Valley	39.8	+3.7	+16.9	1.60	−0.3	−0.4	5.4	−0.1	74	+4
Northern slope	30.9	+0.1	+10.2	0.68	−0.4	−0.7	5.6	+0.2	68	0
Middle slope	44.3	+1.8	+ 7.0	1.36	−0.1	+0.1	5.8	+1.1	68	+7
Southern slope	52.7	−0.5	− 3.0	2.77	+1.8	+1.6	4.6	+0.3	59	+5
Southern Plateau	48.0	−3.0	− 9.2	0.87	+0.4	−0.3	3.3	−0.4	49	+8
Middle Plateau	40.4	−0.5	− 1.0	0.79	−0.5	−1.1	5.1	+0.1	59	+1
Northern Plateau	42.1	+1.8	+ 7.4	1.36	−0.2	0.0	6.4	+0.6	64	−2
North Pacific	45.7	+0.8	+ 3.9	4.41	−0.3	+2.4	6.8	+0.2	80	+1
Middle Pacific	49.3	−2.0	− 2.3	3.41	−0.8	+0.7	5.3	0.0	77	+2
South Pacific	53.9	−1.6	+ 1.1	2.11	−0.5	−2.5	4.7	+0.1	71	0

[1] An account, with a map, of this storm will appear in the April REVIEW.
[2] See pp. 167–168 above.

Winds of 50 mis./hr. (22.4 m./sec.) or over, during March, 1919.

Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.
		mi./hr.				mi./hr.				mi./hr.				mi./hr.	
Asheville, N. C.	8	50	e.	Evansville, Ind.	17	58	sw.	New York, N. Y.	28	92	nw.	Point Reyes Light, Calif.	8	61	nw.
Block Island, R. I.	28	70	nw.	Fort Smith, Ark.	16	58	sw.	Do.	29	87	nw.	Do.	12	62	se.
Do.	29	60	nw.	Hannibal, Mo.	16	50	sw.	Do.	30	50	nw.	Do.	13	58	sw.
Do.	30	50	nw.	Hatteras, N. C.	26	50	nw.	Norfolk, Va.	27	52	nw.	Do.	14	58	nw.
Buffalo, N. Y.	1	76	sw.	Do.	27	51	nw.	Do.	28	56	nw.	Do.	15	58	nw.
Do.	9	72	sw.	Indianapolis, Ind.	16	54	s.	Do.	29	52	w.	Providence, R. I.	9	52	s.
Do.	10	50	sw.	Lexington, Ky.	17	68	sw.	North Head, Wash.	1	58	s.	Do.	10	59	nw.
Do.	12	52	sw.	Little Rock, Ark.	8	52	w.	Do.	4	52	s.	Do.	28	55	se.
Do.	18	64	s.	Louisville, Ky.	17	56	sw.	Do.	6	56	nw.	Do.	29	52	nw.
Do.	28	50	nw.	Lynchburg, Va.	27	51	n.	Do.	7	50	se.	St. Louis, Mo.	8	50	ne.
Canton, N. Y.	1	51	w.	Memphis, Tenn.	8	54	nw.	Do.	10	60	s.	Sandy Hook, N. J.	1	58	se.
Cheyenne, Wyo.	1	50	w.	Modena, Utah	13	56	s.	Do.	14	52	s.	Do.	9	55	se.
Do.	14	56	w.	Mount Tamalpais, Calif.	5	56	nw.	Do.	15	58	s.	Do.	19	51	n.
Cleveland, Ohio.	18	56	w.	Do.	12	56	se.	Do.	16	54	s.	Do.	28	74	nw.
Columbus, Ohio.	17	52	w.	Do.	13	52	sw.	Do.	17	72	s.	Do.	29	69	nw.
Detroit, Mich.	1	50	sw.	Do.	15	62	nw.	Do.	30	54	s.	Tatoosh Island, Wash.	10	63	s.
Duluth, Minn.	26	50	w.	New York, N. Y.	1	64	s.	Oklahoma, Okla.	15	50	s.	Do.	15	51	w.
Eastport, Me.	9	51	se.	Do.	5	50	nw.	Oswego, N. Y.	28	50	nw.	Do.	17	62	s.
Do.	28	56	e.	Do.	6	50	nw.	Pensacola, Fla.	8	60	s.	Do.	30	52	s.
Ellendale, N. Dak.	14	52	e.	Do.	9	65	w.	Do.	26	52	sw.	Toledo, Ohio.	1	50	sw.
El Paso, Tex.	15	56	nw.	Do.	10	60	nw.	Point Reyes Light, Calif.	3	61	nw.	Trenton, N. J.	28	62	nw.
Erie, Pa.	8	60	se.	Do.	19	51	n.	Do.	5	62	nw.	Do.	29	54	nw.
Do.	9	67	se.	Do.	21	50	n.	Do.	6	80	nw.	Wichita, Kans.	18	88	nw.
Do.	16	52	se.	Do.	22	54	n.	Do.	7	51	nw.	Williston, N. Dak.	14	52	se.
Do.	18	52	sw.	Do.	27	51	se.								

SPECIAL FORECASTS AND WARNINGS, WEATHER AND CROPS.

WEATHER WARNINGS.

By EDWARD H. BOWIE, Supervising Forecaster, Washington District.

At the beginning of the month a LOW was passing down the St. Lawrence Valley and a trough of relatively low pressure covered the Atlantic States. In the southern end of this trough a secondary center developed and moved eastward, attended by rains along the south Atlantic coast. This low pressure system was followed during the 2d and 3d by high barometer and relatively low temperatures east of the Mississippi River. The evening of the 3d, when an extensive system of low pressure was over the West with a storm center over Lake Superior and another over the southwestern Rocky Mountain Region, warnings of strong winds and snow were sent to open ports on Lake Michigan and cold-wave warnings ordered for Upper Michigan. This low pressure system advanced eastward, the northern storm center passing rapidly down the St. Lawrence Valley and disappearing on the 5th, while the southern storm center moved east-northeastward and reached the Atlantic coast on the 6th. General rains were forecast for the Washington District in advance of these LOWS and much colder weather and high barometer advanced eastward in their wakes. Violent local storms occurred on the 5th in the East Gulf and South Atlantic States, attending the eastward passage of the southern storm center just referred to. On the morning of the 4th cold-wave warnings were ordered for Michigan, except the southeast portion, and for northwestern Indiana, and the evening of the same day the display of cold-wave warnings was extended to cover southeastern Michigan, eastern and southern Indiana, Kentucky, east and central Tennessee, Mississippi and Alabama. On the 5th the display of cold-wave warnings was extended to Georgia, North and South Carolina, and northwestern Florida. Much colder weather covered these regions but the fall in temperature was less than that required to justify cold-wave warnings. At 3 p. m. of the 5th when the center of the disturbance was over the upper Ohio Valley, northwest storm-warnings were displayed on the Atlantic coast at and north of Cape Hatteras and during the night of the 5th strong winds, and in some places gales, occurred in the region where warnings were displayed. The next storm of importance to cover the Washington District was central at 8 a. m. of the 8th over eastern Texas, having moved to that region from Nevada in the preceding 48 hours. This storm moved rapidly northeastward and increased greatly in intensity. At 8 a. m. of the 9th, its center (29.40 inches) was at Toledo, Ohio, and at the same hour on the 10th its center (29.18 inches) was near the mouth of the St. Lawrence River. General and heavy rains and gales attended this cyclone during its passage across the Washington Forecast District. On the morning of the 8th storm warnings were displayed on the Gulf coast at and between Bay St. Louis and Tampa and on the Atlantic coast at and between Titusville, Fla., and Cape Henry. At 4 p. m. of the 8th warnings were ordered for the coast north of Cape Henry to Boston and at 10 p. m. of the same day the region of storm warning display was extended northward to Eastport.

Warnings of northeast gales and snow were sent open ports on Lake Michigan. Gales occurred as forecast and there were heavy snows in parts of lower Michigan. The air pressure increased and remained above normal after the eastward passage of this storm until the 15th. Warnings of the coming of high winds were dispatched to open ports on Lake Michigan on the 12th and 13th and on the latter date northeast storm warnings were displayed on the Atlantic coast at and between Sandy Hook and Eastport. On the morning of the 13th cold-wave warnings were ordered for New England and considerably colder weather followed during the succeeding 24 hours. On the 15th the pressure had become subnormal generally west of the Mississippi River, with storm centers over North Dakota and New Mexico and rains had already set in over the great central valleys. This low pressure system advanced slowly eastward and rains continued over much of the country east of the Mississippi River until the 19th. On the 16th and 17th heavy and general rains and local wind storms occurred in the Ohio and lower Mississippi Valley and the East Gulf States. These conditions had been previously forecast. Warnings of strong winds were sent to open ports on Lake Michigan on the 16th and 17th, and on the 17th at 3 p. m. storm-